

Method of Test for
**DETERMINING TOTAL MOISTURE AND FREE MOISTURE
IN AGGREGATE (COARSE AND FINE)**
DOTD Designation: TR-106-11

Method A –Rapid Drying

I. Scope

- A. This procedure is designed to determine the total moisture and free moisture contents of coarse and fine aggregates for Portland cement concrete by drying the material on a hot plate.
- B. Reference Documents:
 - 1. DOTD TR 108 – Splitting and Quartering Samples
 - 2. AASHTO T 84 – Specific Gravity and Absorption of Fine Aggregate
 - 3. AASHTO T 85 – Specific Gravity and Absorption of Coarse Aggregate.

II. Apparatus

- A. **Scales**
 - 1. 20 lb. or greater capacity sensitive to 0.01 lb.
 - 2. 10 kg capacity sensitive to 1 g.
 - 3. 1 kg or greater capacity sensitive to 0.1 g.
- B. **Electric or gas hot plate** – an open flame hot plate shall be equipped with a suitable shield to disperse heat evenly and to prevent direct contact of the flame with the drying pan.
- C. **Pans** – sufficient to hold sample without spilling and large enough to spread the material for rapid drying.
- D. **Brush**
- E. **Stirrer** –spoon or spatula
- F. **Thermal gloves, apron, tools, eye protection** –for handling hot materials.
- G. **Portland Cement Concrete Plant Report** – DOTD Form No. 03-22-4040(Figure 2)

III. Health Precautions

Proper equipment and precautions are to be used whenever hot materials or equipment must be handled. Use container holders for gloves while

handling hot containers. Wear eye protection while stirring and weighing the heated material due to possible shattering of particles.

IV. Sample

The entire sample may be used to determine moisture content. If a representative portion is used, obtain the representative portion in accordance with DOTD TR 108.

The following minimum sizes will apply:

- A. Fine Aggregate –500 g
- B. Coarse Aggregate –10 lb.
- C. Lightweight Aggregate –2000 g

V. Procedure

- A. Place wet material in a drying pan of known tare weight. Weigh and record the weight of the wet material and pan as B to the nearest 0.01 lb, 1 g, or 0.1 g depending on the sensitivity of the scale.
- B. Place pan containing wet material on the hot plate and heat, stirring constantly to accelerate drying and to avoid localized overheating.
- C. Do not lose any particles from spillage or adherence to the stirrer. Brush material adhering to stirrer into pan. Control heat to avoid loss of material from exploding particles. Dry to a constant weight.

NOTE A-1: *Constant weight for drying purposes is defined as less than 0.1% weight loss between successive weighings no less than 5 minutes apart.*

- D. Cool the pan and dried material until the pan can be handled without

gloves. Weigh the pan with the material and record as C to the nearest 0.01 lb, 1 g, or 0.1 g, depending on the sensitivity of the scale.

V. Calculations

- A. Subtract the tare weight of pan from the weight of dried material and pan to determine the weight of dried material and pan to determine the weight of the dried material and record as E to the nearest 0.01 lb, 1 g, or 0.1 g, depending on the sensitivity of the scale.
- B. Determine the weight of water in the material by subtracting the weight of the dried material and pan from the weight of the wet material and pan and record as D to the nearest 0.01 lb, 1 g, or 0.1 g, depending on the sensitivity of the scale.
- C. Calculate the total moisture content, %, (F) to the nearest 0.1 % using the following formula:

$$F = \frac{D \times 100}{E}$$

where,

D = wt. of water, lb or g
 E = dry wt. of material, lb or g
 100 = constant

example,

D = 25.0 g
 E = 510.0 g

$$F = \frac{25.0 \times 100}{510}$$

$$= \frac{2500}{510.0}$$

$$= 4.901$$

$$F = 4.9\%$$

- D. Calculate the free moisture content, %, (H) to the nearest 0.1% using the following formula:

$$H = F - G$$

where,

F = total moisture content, %
 G = absorption factor, %
 (determined by AASHTO T 84 or 85)

example:

F = 4.9
 G = 0.3

$$H = 4.9 - 0.3$$

$$H = 4.6\%$$

VI. Report

- A. Report the total moisture content to the nearest 0.1%.
- B. When the free moisture content of sample is calculated, report the free moisture content to the nearest 0.1%.

VII. Normal Test Reporting Time

Normal test reporting time is one hour.

DOTD Designation: TR 106-11

Method B – Oven Drying

I. Scope

- A. This procedure is designed to determine the total moisture and free moisture contents of coarse and fine aggregates for Portland cement concrete, Blended Calcium sulfate (BCS), and Reclaimed Asphalt Concrete Pavement (RAP) by drying the material in an oven.
- B. Reference Documents:
 1. DOTD TR 108 – Splitting and Quartering Samples
 2. AASHTO T 84 - Specific Gravity and Absorption of Fine Aggregate
 3. AASHTO T 85 – Specific Gravity and Absorption of Coarse Aggregate

II. Apparatus

- A. **Scales**
 1. 20 lb or greater capacity sensitive to 0.01 lb.
 2. 10 kg capacity sensitivity to 1 g.
 3. 1 kg or greater capacity sensitive to 0.1 g.
- B. **Oven** – approved thermostatically controlled, ventilated oven, capable of maintaining a temperature of $230\pm 9^{\circ}\text{F}$ ($110\pm 5^{\circ}\text{C}$), $131\pm 9^{\circ}\text{F}$ ($55\pm 5^{\circ}\text{C}$), and $100\pm 9^{\circ}\text{F}$ ($38\pm 5^{\circ}\text{C}$).
- C. **Pans** – sufficient to hold sample without spilling and large enough to spread the material for rapid drying.
- D. **Thermal gloves, apron, tools, eye protection** – for handling hot materials.
- E. **Portland Cement Concrete Plant Report** – DOTD Form No. 03-22-4040 (Figure 2).

III. Health Precautions

Proper equipment and precautions are to be used whenever hot materials or equipment must be handled. Use container holders or gloves while handling hot containers. Wear eye protection while stirring and weighing the heated material due to possible shattering of particles.

IV. Sample

The entire sample may be used to determine moisture content. If a representative portion is used, obtain the representative portion in accordance with DOTD TR 108.

The following minimum sizes will apply.

- A. Fine Aggregate – 500 g
- B. Coarse Aggregate – 10 lb
- C. Lightweight Aggregate – 2000 g

V. Procedure

- A. Place wet material in a drying pan of known tare weight. Weigh and record the weight of the wet material and pan as B to the nearest 0.01 lb, 1 g, or 0.1 g, depending on the sensitivity of the scale.
- B. Place pan containing wet material in the oven at a temperature as indicated in Figure 1 and dry to a constant weight.

Note B-1: Constant weight for drying purposes is defined as less than 0.1% weight loss between successive weighings no less than 15 minutes apart.

MATERIAL	TEMPERATURE
Reclaimed Asphaltic Concrete Pavement (RAP)	$100\pm 9^{\circ}\text{F}$ ($38\pm 5^{\circ}\text{C}$)
Blended Calcium Sulfate (BCS)	$131\pm 9^{\circ}\text{F}$ ($55\pm 5^{\circ}\text{C}$)
Other Aggregates	$230\pm 9^{\circ}\text{F}$ ($110\pm 5^{\circ}\text{C}$)

Figure 1

- C. Cool the pan and dried material until the pan can be handled without gloves. Weigh the pan with the material and record as C to the nearest 0.01 lb, 1 g, or 0.1 g, depending on the sensitivity of the scale.

VI. Calculations

- A. Subtract the tare weight of pan from the weight of dried material and pan to determine the weight of the dried material and record as E to the nearest 0.01 lb, 1 g, or 0.1 g, depending on the sensitivity of the scale.
- B. Determine the weight of water in the material by subtracting the weight of the dried material and pan from the weight of the wet material and pan and record as D to the nearest 0.01 lb, 1 g, or 0.1 g, depending on the sensitivity of the scale.
- C. Calculate the total moisture content, %, (F) to the nearest 0.1% using the following formula:

$$F = \frac{D \times 100}{E}$$

where,

D = wt. of water, lb or g
 E = dry wt. of material, lb or g
 100 = constant

example,

D = 0.23 lb
 E = 10.09 lb

$$F = \frac{0.23 \times 100}{10.09}$$

$$= \frac{23}{10.09}$$

$$F = 2.279$$

$$F = 2.3\%$$

- D. Calculate the free moisture content, %, (H) to the nearest 0.1% using the following formula:

$$H = F - G$$

where:

F = total moisture content, %
 G = absorption factor, %
 (determined by AASHTO T 84

or

85)

example:

F = 2.3
 G = 0.8

$$H = 2.3 - 0.8$$

$$H = 1.5\%$$

IX. Report

- A. Report the total moisture content to the nearest 0.1%.
- B. When the free moisture content of sample is calculated, report the free moisture content to the nearest 0.1%

X. Normal Test Reporting Time

Normal test reporting time is 24 hours.

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT PORTLAND CEMENT CONCRETE PLANT REPORT						DOTD 03-22-4040 3/85	
Project No. <u>842-61-0097</u>		Date <u>1-8-93</u>		Lot No. <u>1</u>		Mix Design No. <u>1</u>	
Plant <u>ABC Ready Mix</u>		Location <u>Baton Rouge</u>					
Concrete (Class/Type) <u>Class A</u>		Min Cement Factor <u>6.0</u>		Bags Cu Yd		Max Water-Cement Ratio <u>6.0</u>	
Total Cubic Yards Today _____		Scales Balanced: Time _____		AM PM		AM PM	
Mix Proportions From Mix Design							
Cement _____ lb		Fly Ash _____ lb		Fine Aggregate (SSD) _____ lb			
Coarse Aggregate (SSD) _____ lb		Water Reducer _____ oz		Air Entrainment _____ oz			
Moisture and Batch Weight Computations for One Cubic Yard							
Aggregate Tests				TEST 1		TEST 2	
				FINE	COARSE	FINE	COARSE
Time of Test							
A	Tare weight, gm or lb			<u>192.5</u>	<u>1.95</u>		
B	Wet weight (A + sample), gm or lb			<u>722.5</u>	<u>12.27</u>		
C	Dry weight (A + sample), gm or lb			<u>702.5</u>	<u>12.04</u>		
D	Weight of water (B-C), gm or lb			<u>20.0</u>	<u>0.23</u>		
E	Dry weight of sample (C-A), gm or lb			<u>510.0</u>	<u>10.09</u>		
F	Percent total moisture (D/E), %			<u>4.9</u>	<u>2.3</u>		
G	Absorption factor %			<u>0.3</u>	<u>0.8</u>		
H	Percent free moisture (F-G), %			<u>4.6</u>	<u>1.5</u>		
I	Pounds of aggregate/cu yd (SSD) from mix design						
J	Corrected weight (1 + (H/100)) I, lb						
K	Free water (J-I), lb						
L	Free water (K/8.34), gal						
Allowable Water Calculations for One Cubic Yard							
M	Total admixture (ounces from mix design/128), gal						
N	Total free water (L for fine and coarse agg. + M), gal						
O	Maximum allowable water (from mix design), gal						
P	Maximum allowable water to be added (O-N), gal						
Q	Minimum allowable water to be added (.75P), gal						
Total Batch Weight Calculations							
R	Batch size, cu yd						
S	Cement (R x mix design weight), lb						
T	Fly Ash (R x mix design weight), lb						
U	Fine aggregate (R x J), lb						
V	Coarse aggregate (R x J), lb						
W	Maximum water to be added (R x P), gal						
X	Minimum water to be added (R x Q), gal						
Y	Water reducing admixture (R x mix design weight), oz						
Z	Air entraining admixture (R x mix design weight), oz						
Batch Water Adjustments For Ice							
AA	Pounds of ice added per cu yd						
BB	Gallons of ice (AA x R/8.34 = gal per batch)						
CC	Adjusted maximum water to be added (W-BB), gal						
DD	Adjusted minimum water to be added (X-BB), gal						
Remarks _____							
<u>B. K. Hunt</u> Concrete Technician				<u>A. J. Mitchell</u> Department's Certified Inspector			

Figure 2
Portland Cement Concrete Plant Report
(Methods A and B)